PBL Characterization Web Site

An important parameter in both weather and climate models is the depth of the turbulent boundary layer. The depth of this layer determines the strength of vertical mixing of pollutants and the diurnal variation of surface temperature and moisture. The depth of the boundary layer can affect the vertical profile of wind speed near the surface, and thereby influence the amount of energy available for wind turbines. The boundary layer also frequently determines the amount of convective potential energy available to fuel summertime thunderstorms. Despite its importance, the depth of the turbulent boundary layer is rarely measured. More often related parameters are measured, such as mean temperature or humidity profiles, or the depth of aerosol layers. These parameters are correlated with the depth of the turbulent boundary layer, but estimates of the boundary layer based on them are often far different from the true depth of the turbulent boundary layer.

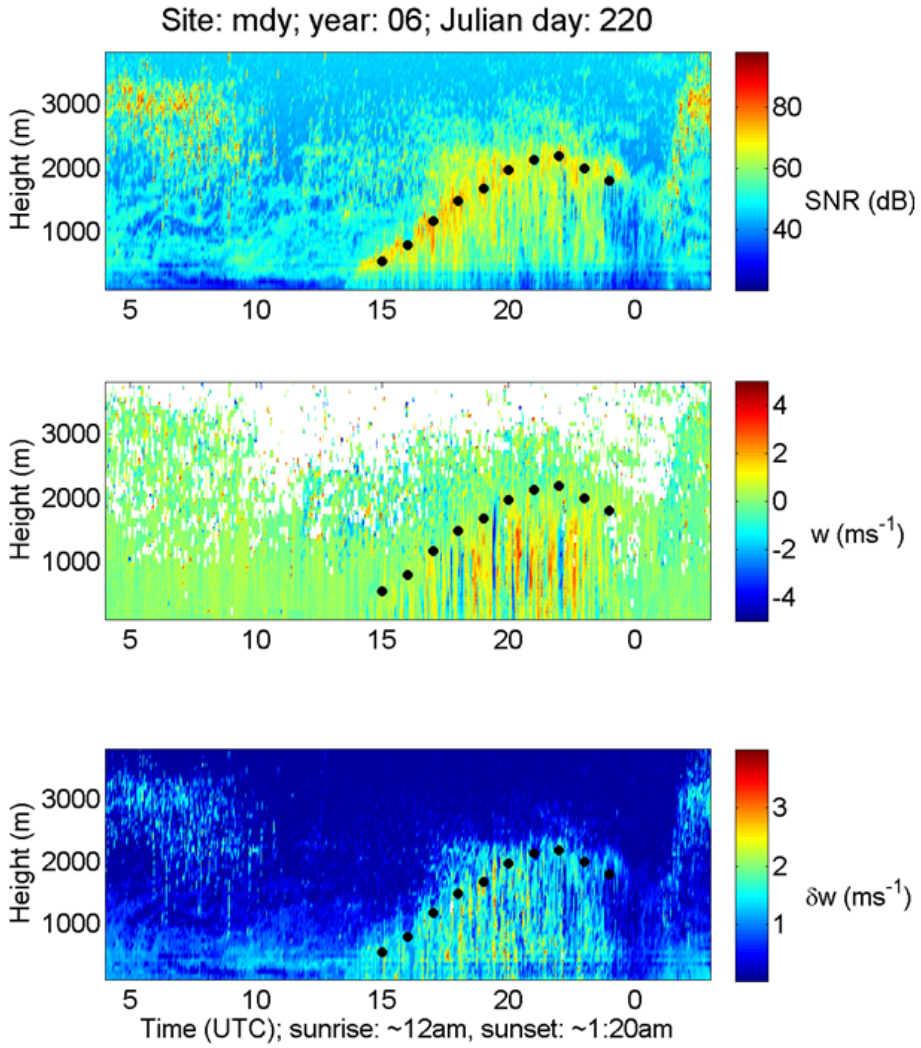
PSD has developed a method to automatically detect the depth of the convective turbulent boundary-layer using observations from wind profiling radars. Three radar parameters are used in the calculation of the boundary layer depth: radar reflectivity, variance of vertical velocity, and spectral width (a measure of the turbulence intensity). A fuzzy-logic based algorithm combines measurements of the vertical profiles of all three parameters to determine the depth of the turbulent boundary layer. The algorithm also provides a confidence factor that can be used to reject boundary layer depth estimates if the observed boundary layer structure differs too greatly from the conceptual model of the boundary layer built into the algorithm.

The automatic boundary layer depth algorithm has been applied to data from networks of wind profiler radars from several air quality field programs. It is now also being applied in real-time to several of PSD's 915 MHz wind profilers deployed for various field programs. We provide these real-time boundary layer depth values to NWS/NCEP for evaluating NOAA's operational weather forecast models.

References:

Bianco, L., and J. Wilczak, 2002: Convective Boundary-Layer Depth: Improved Measurement by Doppler Radar Wind Profile Using Fuzzy Logic Methods. *J. Atmos. Oceanic Tech*., 19, 1745-1758.

Bianco, L., J. M. Wilczak, and A. B. White, 2007: Convective boundary layer depth estimation from wind profilers: statistical comparison between an automated algorithm and expert estimations. Accepted by J. Atmos. Oceanic Tech.



Time-height cross-section of radar reflectivity (expressed as signal-to-noise ratio SNR), vertical velocity (w), and spectral width (δ w) from a 915 MHz wind profiling radar for a 24h time-period. Black dots indicate hourly values of the depth of the convective boundary layer derived from the fuzzy logic algorithm.